SUPPLEMENT.

# The Mining Journal,

## RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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### LOSS OF LIFE IN CORNISH MINES.—No. III.

We have already shown that Cornish miners suffer from great excess of disease, especially from consumption; that their lives are thereby shortened on the average eight or nine years, and their period of working ability still more reduced; that their wives are unusually exposed to the privations of widowhood, and their children to the dangers of early orphanage, while they themselves suffer a greater loss of life from excess of consumption than colliers do from accident even in the most dangerous districts, with the aggravation of its being preceded by lingering, always distressing, and sometimes painful disease. We now proceed to enquire what are the chief causes of that excessive disease, with all its attendant losses, evils, privations, and miseries? Are they susceptible of very great abatement? Will not the saving produced by such abatement, by protecting the men from the risk—nay, the all but certainty—of premature death, save their employers from costs and expenses, which will amply repay them for the outlay necessary to enable mining to be carried on without the waste of life it now involves? We do not mean to assert the probability of mining being rendered either an agreeable or a healthy occupation, but we do say there is no occasion for the excessive loss of life with which it is now accompanied. It may be that that loss may ultimately be reduced to a degree beyond our present hopes, sanguine as they are; and none can deny that it is alike our duty and our interest to reduce its dangers to the lowest possible amount. We have also a right to demand, and we do demand, the most careful and searching enquiry into a matter of such vital interest.

Miners' consumption being the chief cause of the premature deaths of miners, if we discover and remove the principal causes of that disease we shall prevent the chief part of the evil. As our readers are now well aware, consumption is not unusually prevalent among the non-mining population of Cornwall, nor among the female part of the mining population, nor among coal miners; it cannot, therefore, be caused by the climate of Cornwall, or it would affect all its inhabitants proportionately; or by the hereditary constitution or mode of life at home, or by the habitations of miners, or it would affect the women like the men; nor can it be from working underground simply, or colliers would be as liable to it as copper miners, instead of being unusually exempt. Whatever be the causes of the enormous excess of consumption among Cornish miners, they must be such as operate upon those who work underground alone, and which do not exist in coal mines, which are as deep, as dark, as wet, and naturally as hot and as dusty as copper mines. If we enquire in what does the chief difference between copper and coal mines consist, we shall find that the latter are very well, the former very badly, ventilated. The air in coal mines feels comparatively pure and fresh; the temperature is reduced, the colliers are lowered into and raised from coal pits by mechanical power, and are not exhausted by climbing long ladders; nor have they as much exhausting toil as copper miners in beating the borer, while their earnings are higher and less irregular, and probably their diet is more nutritious. But we doubt whether in their conduct and habits they are as sober and regular as our Cornish friends.

That it is these differences between coal and copper mines, and especially their good or bad ventilation, that cause the vast difference as to the liability to consumption of the two classes of miners is the all but universal opinion of those medical authors who have written on the subject, and there can be little doubt that that opinion is correct. Coal mines are better ventilated, because, as is well known, they are liable to accumulations of gas which, mixed with air in certain proportions, is highly explosive, and is in many mines generated so rapidly as would soon fill them with gas, which cannot be breathed at all. Ventilation of such mines is, therefore, not merely desirable but indispensable, as failing in it they cannot be worked without great and immediate danger, or in many cases not at all. It is probable that this liability of coal mines to gather explosive gas, by compelling their ventilation, causes more lives to be indirectly saved than are directly destroyed by the fearful catastrophes which ventilation only imperfectly guards against; for if coal mines were as badly ventilated as copper mines usually are, consumption in them would, in all probability, be as frequent as in the latter, and if so, a far greater number of lives would be lost by disease than are now destroyed by explosions, even in the most recklessly managed collieries. But, it may be asked, what is the proof that copper mines are badly ventilated, and that their bad air causes miners' consumption? That they are badly ventilated is proved both by common observation and by scientific experiment. Thus, it is very common for miners to be absolutely unable to work continuously because of poor air. Sometimes they cannot breathe at all, or keep their lights burning, unless they leave the sett from time to time to allow of a change of air. This shows that the oxygen, or vital air, is consumed faster than it is changed, and it is not surprising that breathing such air does great injury to the delicate organs upon which it directly acts. It is, indeed, wonderful that the men exist at all in some of the air they are obliged to breathe. For example, air in its natural state—in that for which our lungs are adapted by their Maker—contains about 21 per cent. of oxygen. If animals be confined in air the proportion of oxygen of which is reduced to 14 per cent., or four-sixths of the usual proportion, they very quickly die; and if the air contained no oxygen at all they would be drowned just as effectually as if they were put under water. Samples of air from copper mines have been found to contain only 17 per cent. of oxygen gas—that is, one-sixth of the whole quantity naturally contained is consumed; and if two-sixths of it were removed, man or beast confined in it must quickly die. Such deterioration of the air is not rare or occasional, but common. There is scarcely a mine in the county where working is not frequently impeded, and occasionally even partially stopped, for want of air; and, we must recollect, men will work if they can only get their lights to burn. "The condition of a miner," said Mr. Mackworth, "could be realised, if a room containing a number of persons were hermetically sealed until the temperature were raised by many degrees, and until the lights burned dimly." Almost every one has felt the misery of breathing the foul air of a close room; but it is rare, indeed, for a room to be so close as to allow the oxygen it contains to be reduced to five-sixths of its natural amount. Few who stay above ground have seen their lights grow dim from want of air, or been obliged to put their candles on the slope to keep them alight—in fact, the closest of close rooms is airy as compared with the dead end of a mine, which those only who have experienced it can realise.

Both the miners themselves and their medical attendants attribute a large portion of their excessive liability to consumption to the poor air they habitually breathe, an opinion in complete accordance with that of other observers. Thus it is a well established fact that indoor labourers suffer much more frequently from diseases of the lungs than those who, working out of doors, breathe a better air. The excessive disease of the lungs among soldiers is attributed in a great measure to the bad ventilation of barrack dormitories, and to their improvement is the recent great diminution of the disease among soldiers chiefly due. The often-quoted case of the monkeys in the Zoological Gardens proves that the same causes produce like effects on monkeys as on men. A large number of these poor beasts, kept in a glass house without proper ventilation, died rapidly of consumption; another set, kept in the same house after it was ventilated, were far more healthy.

The poor air of mines has both great deficiency of oxygen and excess of deleterious, or, at least, irritating gases, and other products arising from various sources, such as respiration, combustion of candles, and powder smoke. One form of poor air is very expressively called by the miners "cold-damp." Its effects, as described by Mr. Lanyon, are similar to those produced either by breathing carbonic acid gas in excess or oxygen gas in deficiency. There is first a sensation of coldness, quickly succeeded by giddiness and pain in the head, sickness, prostration of strength, particularly of the knees, tremors, and an almost unconquerable disposition to sleep. These are the symptoms of very imperfect arterialisation of the blood, and show that the oxygen breathed is barely enough to maintain life at all. More commonly there is a disagreeable feeling of heat, greater than is due to the temperature of the air, high as that is, and probably arising in part from the air being saturated with moisture, and, therefore, incapable of carrying off that exhaled by the lungs, whereby the perspiration of the skin is inordinately increased, and the cooling effect of perspiration diminished. Often there is so much powder smoke that work has to be suspended, to allow time for it slowly to clear partially away: mixed with this are the fumes of candles burning imperfectly, and animal effluvia from the breath and perspiration, from men making violent exertion, in an atmosphere saturated with moisture, with the temperature of a hothouse. "That breathing an atmosphere of this kind," says Mr. Lanyon, "should produce coughs, palpitation of the heart, headache, giddiness, thirst, profuse perspiration, and debility, will not surprise us much, but it is after a long continuance in such an ill-ventilated place that we find the miner exhibiting the most wretched aspects—pale, sallow, and emaciated—complaining of loss of appetite, sickness, heartburn, pyrosis, flatulence, cough, difficulty of breathing, palpitation, dizziness, debility, not always in the order in which they are noticed here, but varying as one or other of the viscera is most affected."

Of course the air is not always, and in all parts of the mine, so bad as above described, for if it were the men would be killed off quickly, whereas, as we have seen, it is not until they become 40 or 50 years old that there is a marked destruction of life among them. But the disease which ultimately kills them begins much earlier, is partially recovered from, and is again excited, until at last, at an age when other men are in the prime of life, and strength, and usefulness, the poor miner is, in a great majority of instances, either sinking prematurely into the grave, or becoming a confirmed and hopeless invalid. The first morbid action which is generally set up is irritation of the mucous membrane of the lungs, frequent repetition of which produces chronic inflammation, with thickening of this membrane, accompanied by a purulent or viscid and gleety discharge in the expectoration, which is sometimes rendered black by the powder smoke. An extension of this inflammation of the membrane to the substance of the lung is of frequent occurrence, as also is pleurisy. The imperfect arterialisation of the blood, says Mr. Lanyon, will naturally occasion vitiated secretions and diminished nervous influence, which the brain, acted upon by black blood, is disqualified from furnishing to the digestive organs. Mr. Thackray, in his work on Trades, states what everyone's experience confirms, that "the first symptoms of bad ventilation frequently arise in the stomach," and this agrees with the condition of the organ as observed in miners. It will be remembered that we stated that Mr. Lanyon found on examination that three times as many miners as labourers suffered from indigestion, and four times as many from cough, or other diseases of the chest. If any of our readers desire fuller information on this point, we beg to refer them to Mr. Lanyon's essays on the Diseases of Miners, published in the Reports of the Royal Polytechnic Society of Cornwall, particularly that in the sixth report, and also to Dr. Barham's excellent report. We think it, however, unnecessary to quote more to prove what must be now sufficiently evident, that we have good ground for expecting large diminution of mortality if ventilation of the mines be properly effected.

Though the saving of life would be the first and most important object in improving ventilation, it would not be the only good attained. It is useless to prove, what everyone must have more or less experienced, that men who are ill cannot do as much work as if they were in full health. The disease by which miners are chiefly destroyed is one of very gradual progress; and, of course, if a very large proportion of miners die of it, a very large proportion of those at work must be suffering from it in a more or less advanced stage. The lungs of a man have been not unaptly compared to the boiler of a steam-engine, and a man can no more work effectively with ineffective respiration than an engine can when short of steam. But whether miners work effectively or not, they must be paid at a rate which will tempt men to become and to continue miners, and, therefore, the pecuniary loss of their ineffective work falls chiefly, if not exclusively, upon their employers, and any profit which can be produced by rendering their work more effective would also be reaped chiefly by their employers. This would be the ultimate result in all cases, but the adjustment of earnings in proportion to effective work done would be more rapidly made in mining than in almost any other employment, in consequence of the peculiar manner in which miners are generally paid. They are not paid simply by the day, or by the piece, and there are no trade unions to fix an arbitary or customary scale of payment; but at short intervals the work is let to the men on tribute, and they, of course, reckon upon being able to do the amount of work which they actually find they can do. If, therefore, miners generally were rendered capable of doing more work than they now do, they would almost immediately offer terms of tribute more advantageous to the adventurers than they can now afford. But, it may be answered, this profit or saving to the adventurers in consequence of diminished disease among their miners would not be immediate, as it would not occur until there had been sufficient lapse of time to allow of the proportion of diseased miners being much less than it now is, and it is true the full amount of the saving would not quickly follow.

A large amount of it would, however, be produced immediately for the effective working power of healthy men, and still more of those whose respiratory organs are diseased, is very materially diminished when they are breathing air impure, hot and moist, like that of a mine. Heat and moisture alone are great impediments to hard work, as everyone has felt. That which is pleasant exercise on a cool breezy day of spring, is exhausting toil on a hot close day of summer. But the air of mines is that of a hot-house, but with only five-sixths the proper proportion of oxygen; and to work in it with the same energy, strength, and activity as if it were fresh and cool is simply impossible. This is not a matter of speculation, for Mr. Mackworth ascertained that men in the same state of health did 20 per cent. less work in a coal mine badly ventilated than when it was well ventilated. In other words, 100 instead of 80 men, had to be employed and paid to do the same amount of work. As it would cost very much less than 20 per cent. of the men's earnings to secure as much ventilation as is desirable, it is clear there would be great profit from good ventilation, if the saving in effective work wasted were the only saving to be expected. But work in mines is often not merely rendered more costly, but very much impeded, and occasionally stopped for want of air. Candles cannot be kept alight, and it is long before powder smoke is cleared away. The avoidance of this loss of time would be a large addition to the saving. In a badly ventilated mine, moreover, the timber which is so extensively used rapidly rots away, and Mr. Woodhouse, overseer of the Moira Collieries, found that free ventilation tends in a remarkable degree to protect the woodwork of the mine. "Timber," he says, "lasts longer by years." Every ship or housebuilder knows how essential free ventilation is to the preservation of timber, and Mr. Mackworth said that the saving of timber alone would, in most mines, pay for the cost of ventilation. There cannot, therefore, be a doubt that all these savings put together would render the money spent in well-directed ventilation as profitable as that spent in draining, and the time will come, and is, we trust, not far distant, when it will be considered as indispensable.

### MINING IN WALES—No. II.

June 5.—Of the mining districts of Wales and Shropshire, referred to the week before last, I shall first take that of Flintshire and Denbighshire. The lead veins of this district are contained in strata of carboniferous age, which overlie the eastern flanks of the rocks of the Silurian region of North Wales for a length of about 45 miles, from the mouth of the Dee estuary to the River Vyrnwy, in a line bearing about 15° east of south. Along the whole of this length the carboniferous rocks dip east, except, perhaps, at the very northern extremity, about Talargoch Mine; and the denuded edges of the different beds become successsively exposed, in an ascending series, as we proceed from west to east. The lower strata, lying on the Silurian rocks, are classed as carboniferous limestone, being essentially calcareous. Overlying these, and consequently succeeding them on the east, are the sandstone or grit beds, grouped together as the millstone grit; and covering these grits, and hence again succeeding them on the east, come the coal measures. These conclude the carboniferous series, which again east is covered by the new red sandstones of Cheshire and Shropshire.

The veins seem to penetrate the whole of this carboniferous group, being traceable from near the boundary of the Silurian rocks, through the limestone and grit series, even into the coal measures. It is not often, however, that they are traceable into the last-named measures; and even in the various strata into which they are found to penetrate they are by no means indiscriminately or equally productive. This is, of course, no more than is found to be the case in rocks of all classes, for no fact is better established than that the metalliferous produce of veins or lodes is greatly influenced by the mineral or lithological character of their containing rocks; but there is this difference between the case of these carboniferous measure and that of lodes in a "killas" country. In the latter the whole of the strata is so completely metamorphosed by various causes, that the existing lithological conditions of the rocks have little or no relation to their original mineral character—the very stratification, indeed, being often entirely obscured; so that there is no definite connection between the mineral character and geological position of any given portion. In these carboniferous rocks it is very different. Here each geological zone is marked by a deposit of a distinct mineral character, holding constant for long distances, and never varying very widely throughout the whole length of the range, so that we can predict with proximate certainty what will be the character of the strata which any vein will have to traverse in any given place, and hence deduce from experience the probabilities of its being profitably productive or otherwise in that locality. Certain measures are found to be almost wholly unproductive, and are, consequently, classed as "barren;" others produce ore, but rarely in such quantities as to give profit. Others are characterised by producing irregular bunches near the surface, but fail to give anything continuous, while others are known by experience to produce rich and regular courses of ore, and are, consequently, classed as "bearing measures." The position of each of these being proximately known in the geological series, those experienced in the district know where to go to mine with a *possibility* of success; not that of course a vein always does good in the "bearing measures"—that is an uncertainty; but it never does any good out of them—*that is a certainty*. Consequently, in this district, a knowledge of the value and relation of the measures is of the last importance—of much greater importance than a similar knowledge would be in Cornwall, for there it is very rare that any man can distinctly and positively deny that by sinking or driving in any possible direction an existing uncongenial stratum may not alter for the better; whereas in this carboniferous district it is possible proximately to predict the character of the approaching strata with absolute certainty.

In those portions of the carboniferous range under consideration which have proved metalliferous, the lower beds of sandstone and dark and party-coloured shale which are characteristic of the lower developments of the carboniferous series further south, where they attain a considerable thickness, are found wanting, and the Silurian rocks are at once overlain by a very compact whitish limestone. Now, all through the Flintshire and Derbyshire district—from the north of Holywell to the south of Minera—it has been proved by experience that this lower or western limestone cannot afford what can properly be called a mine. In it the veins produce surface bunches, and sometimes pretty good bunches; but the ore never lasts, or never continues in depth, and, in fact, forms in mere squats, utterly inadequate in value to afford any remuneration for regular workings. This part of the series is always dry, and consequently has long been worked, and will probably long continue to be worked, by small bodies of miners in small takes, such as would be called in Cornwall "free setts." When work is dull in the district, a company of three or four men will set to work on one of these, and will probably earn wages from the little squats of ore they find, for permissions are readily granted by the lords' agents for short periods at dues of so much per ton, for the sake of encouraging labour. Until quite recently it was never dreamed in the district of working these western places as regular mines—the notion would have been too absurd; but in the present excitement which is in vogue in this country, I am sorry to say that some of them have been taken up to be worked by "outside companies," and reported to the very skies. It must be remembered that all the veins penetrate this lower limestone, although they prove so comparatively unproductive in it; but below it, into the Silurian rocks (which locally are usually called *grey*, or *blue stone*, according to their colour),

they are generally held not to penetrate, although this view is denied by some. In a scientific point of view, this might be an interesting question to solve, but practically it is immaterial, for it is quite clear that if the veins do penetrate the "bluestone" they are utterly worthless in it, for which we might be prepared by their gradual deterioration as they approach it through the lower limestone.

The width of this compact western limestone varies considerably; it sometimes reaches a width of two or three miles, and at others narrows to as many hundred yards. In the calcareous beds which succeed it on the east we have the "bearing measures," in which the veins first begin to make ore in notable quantities. Although the eye, after a little experience, readily recognises the difference between this "bearing" limestone and the comparatively unproductive western rock, it is not one very easy to describe in words. They are, however, decidedly marked by the absence of that compact structure—approaching sub-crystalline—which characterises the lower beds. But, besides their peculiar mineral character, in order to make productive veins the "bearing measures" must have numerous beds of "shale" interstratified among the limestone stratum. This shale is usually blackish, approaching in colour to the shale of the coal measures, of which it was probably a preliminary deposit, and the beds vary so much in size that their thickness varies from inches to fathoms. In this district these shale beds seem to bear somewhat the same relations to the metalliferous deposits that cross-courses do in Cornwall. Generally speaking, if there is no shale there is no ore; but while the shale beds, like the cross-courses, have undoubtedly some connection with the making of the ore, like them, again, they usually disordered the vein—often, indeed, for a time, seem to annihilate it. Besides this shale, the productive measures als[illegible]es contain beds of dark unproductive limestone, in which the veins [illegible]ly quite barren. High up in the limestone series, approaching the point where it is succeeded by the millstone grit series. There are besides frequent beds of grit and chert (the latter a compact siliceous rock) interstratified among the calcareous beds, which seem to form, as it were, a set of transition beds between the two series. About this point of junction, between the limestone and millstone grit, the veins have at places made splendid bunches of ore; but they seem generally to have been essentially "bunches," although some of them have been rich enough to afford a fine fortune in profits from their working, and, consequently, very different from the small squats found in the western measures. The same observation applies to the veins in the millstone grit; in some places in this series they have made splendid deposits of ore, but in the nature of bunches. The great and regular lead deposits are to be found in the upper limestones.

I have said that the veins have been traced into the coal measures, but I am not aware that they have ever been found productive in them, except possibly at Talargoch. The close contact of rich courses of lead with the coal measures in Minera is probably due to a fault.

As I have stated, the whole of these beds dip east. The angle of the dip varies at various points, but it may probably be averaged at about 11° from the horizon, or 1 in 5; but in some places it is not more than about 8°, or about 1 in 7. As the underlying compact western limestone, the upper bearing limestone with its shales, grits and cherts, and overlying millstone grit and coal measures, all follow the same dip, and as the ore is necessarily associated with the bearing measures and their interstratified shales, it also dips east at the same angle. This brings us to one of the two leading points connected with the practical working of mines in this district—the rapid dip of the ore. The other is the peculiarities of drainage in the limestone, which, while they leave the outcrops of the measures entirely dry to a considerable depth, pour in rivers of water below a certain point. These are points which suggest considerations too wide to be entered upon here, and which I must consequently postpone for another paper, in which I shall also refer to some other general topics affecting mining in the Flintshire and Denbighshire district. The length to which I have this week extended the general geological description may seem extreme; but I am satisfied it is necessary in order to understand the true positions of mines in this district, which are by no means always represented with a very scrupulous regard to accuracy.

## MINING IN SCOTLAND—No. X.

Whatever may be said in high places or by great people, facts wrought out by vulgar hands will convince even the sceptical, stagger obstinacy, and triumph over prejudice. Prejudice, that fatal venom against Scotland, of which I so bitterly complained in all my former articles with headings similar to the present, that passion, infatuation, or by whatever other name physiologists may term the insidious poison, is nowhere so vehement against Scottish metal mining as in Scotland itself. The old Cornish motto, "There's no copper the other side of Truro Bridge," is reiterated; the Scotch cry is—"There is no copper in Scotland, there is no copper in Scotland." The Cornishmen who are in Glasgow, pushing their own interests, and endeavouring to persuade Sandy to adventure in Cornish speculations, join in the cry, take up the echo, and a beautiful chorus they make—"No copper in Scotland, no copper in Scotland; hurra, boys, hurra. The Duke has said so, so nobody can deny it." Now these are facts as incontrovertible as that the sun rises and sets, all of which have been set forth in my former papers, in the last of which I promised to return to the subject during the present season; therefore, permit me to lay before my readers one proof at least of my conclusions, derived from data, the facts of which are equally incontrovertible as the prejudice pre-existing.

On visiting an abandoned copper mine near the village of Lochwinnoch, county of Renfrew, I was much struck by certain indications which I there saw, for though there were neither the "true beautiful killas," or "granite highly mineralised, and congenial for copper ore," of the Cornish mine agent or miner, yet having during my experience learned to judge more from precedent than bias, I at once undertook to re-work the property, provided I could obtain suitable terms and encouragement; this I at length accomplished.

On consulting the land proprietor, I found the former management had been grossly negligent; that the mine had evidently been wrought for the sale of shares and not for sale of ore; that neglect begat short pay, and that, as a natural consequence, ruin; that considerable quantities of ore had been raised, over-dressed, washed, and ill-treated. On examining the lodes and works, the folly of their proceedings become manifest, and displayed error and a thorough want of mining knowledge. The first difficulty was to persuade the landlord to forego high dues; by persuasion and setting the matter in its true light, he consented to take 1-16th instead of 1-12th, as heretofore. The next was to form a company of Scotch gentlemen, who would work the mine for its mineral worth; and here arose the real onus; it would have been easy enough to have formed a company of speculators, and certain parties already in the field with glittering baubles would gladly enough have taken advantage of the opportunity, but to obtain a *bona fide* working company was no easy task. Doubt, fostered on every side; caution, natural to the Scotch character, was exhibited in every possible form and variety.

The precedents of the mine were asked from the very parties who had previously held it. They, of course, could not cry "stinking fish," but strenuously admonished the applicants to have nothing to do with the matter, or shrewdly advised them to spend a few thousands, as they had previously done. These samples were taken, and assayed by public and private authorities innumerable; there positively arose a small demand for nitric acid as soon as the incipient wet analysis became known; prodigious was the demand for pocket magnifying glasses to detect the latent ore. Professors gave astonishing, and private assayists gratifying results; still prejudice could not be overcome, and at length the mine was visited by a certain notability, whose success as a mine adventurer rendered him a small oracle. This worthy pronounced it contained a little copper greens, but not worth working, in his opinion (it cannot be copper, or it would not have been here so long, observed he; if so, you have a mine at once as rich as Devon Consols), as he stood gazing at a lode denuded fully 18 ft. wide, since proved to be copper. Here was a poser; doubt was again redoubled. At last, wading through sloughs of despond, a first-rate company was formed to give the affair a trial—only a trial. On my suggestion the work was commenced on principles diametrically opposite to those previously adopted, with what success the sequel will best show. Ground was broken about the first day of the present year; before two months elapsed a lode containing copper ore was cut; this I shall designate as No. 1. This lode was unknown to the former adventurers; by driving on it we found it to vary from 1 to 5 ft. wide, and it has yielded scores of tons of rich ore, and a splendid lode has gone down in the bottom. A few weeks after No. 2 was cut; this also was a lode which the former workers never saw, and has yielded large quantities of exceedingly rich copper ore by being driven on only; it is 12 ft. wide, and not an inch has been stoped. The end driven into, and on the course of the lode, is 4 ft. wide and 6 ft. high, and is worth 40*l*. per fm.; set to drive by six men, last setting-day, at 7*l*. per fm.; a rich lode for 12 fms. long in back and bottom, the end as good as ever. No. 3, or the lode on which the old men (or old women) worked was tested, and it was found they had only taken a part of the lode, being deceived by a false wall; from this place also large quantities of ore have been, and are being, raised.

Now for the results, to this date; all being from one level or cross-cut. We were ordered by the committee to take a fair average quantity from each lode, and dress it, by merely selecting the ore from the attle, and crush it down, so as to give a fair average produce, that they might neither deceive themselves or the public as to the real value of the mine's produce. This was done to the extent of about 8 tons, and sold to Messrs. Bath and Sons, of Swansea, at 6*l*. 11s. 6d. per ton. A similar parcel has been sent to Liverpool; about 80 tons have been shipped for market, about 150 tons are at surface, and 20 tons broken underground, without entrenching on reserves. Confidence is established, measures are being adopted for vigorous development, and orders have been issued to extend the works. The agents have undertaken to produce 50 to 60 tons a month additional, which will be sent to Swansea to crush, no power being on the mine for that purpose. A deep level has been commenced, and will soon be driven home to take the lodes 10 fathoms deeper than at present; shafts are to be sunk, and the mine properly opened, all the works hitherto executed, including all expenses, have not exceeded 600*l*. It is an easy matter to calculate the fact whether, so far, there is copper in Scotland to pay; the reserves that may be taken away at 3s. in 1*l*. are very great, and the ore at surface will pay all costs and expenses, with something to boot. The fame of this discovery, the novelty of the affair, the absolute contradiction of prejudice, and the beauty of many of the specimens broken, attracted hosts of visitors of every station in life, a Cornish wiseacre captain amongst the rest, who pronounced the ore to be antimony, not copper, and it is now a standing jest, "This is beautiful antimony." Reaction, so natural in all excesses, was not absent in this case. Shares were quoted at fabulous prices, mines were hunted up everywhere, and a fever for mining would certainly have seized the Glasgow public but for the adverse times; a luckly thing for them they may depend, and if productive of no other good it has diverted Scotch attention and capital to Scotch resources, instead of sending it to Cornwall or elsewhere, under specious pretensions and invisible workings. I know that I have run the length of my tether for one article in your pages, therefore *au revoir*.

GEORGE HENWOOD.

## METALLURGY OF SILVER AND LEAD.

The remark which we made some few months since—that the "Metallurgy of Copper," by Dr. Robert H. Lamborn, was calculated to prove, so far as copper was concerned, a worthy rival of our national treatise on metallurgy generally, by Mr. John Arthur Phillips—may be applied with equal truth to Dr. Lamborn's continuation volume on the "Metallurgy of Silver and Lead,"* which has just been issued, the various particulars necessary to be known by the practical man, to enable him to decide the character of the ore he purposes to manipulate, and the readiest means of extracting the metal contained, being carefully and concisely given. Dr. Lamborn has availed himself of the researches of the greatest authorities upon the subject on which he writes, no matter whether they be European or American, English, French, or German, and has thus succeeded in bringing together a mass of matter which it would require long and laborious study to procure elsewhere.

The volume before us commences with very interesting sketches of the history of silver and lead, each chapter leading us from the earliest Biblical period to the present time, and embracing all that need be known concerning the discovery, quantity, and applications of the metals in both the old and the new world. We are then introduced to the physical and chemical properties, and some of the most important artificial compounds of silver. The mode in which oxygen combines with silver, and the several salts of silver, are well described. The physical and chemical properties, and some of the most important artificial compounds of lead, are then treated of in a similar manner, and the oxides and salts are also taken under consideration. An account of the ores and minerals containing silver as an essential constituent occupies the following chapter, whilst the succeeding one embraces the ores and minerals containing lead as an essential constituent. Dr. Lamborn then gives us a chapter on assaying, which alone is worth infinitely more than the entire cost of the book. The "dry way" and the "wet way" are lucidly explained; the various processes employed in the "dry way," according as the assay is made, of ores and furnace products, excepting alloys, of the alloys of silver, or with the blowpipe. With respect to the latter, we may mention the means used for determining the weight by measuring the diameter of the silver globule. It sometimes happens that the silver globule which is produced in the assay of poor ores before the blowpipe is so small that it cannot be weighed. To extend the usefulness of the instrument to cases of this nature, Edward Harkort contrived a scale for the purpose of measuring the diameter of the globule, which is sufficient to determine its weight, since the weights of metallic spheres are to each other as the cube of their diameter. For this purpose he used a tablet of ivory, upon which two fine diverging lines were drawn; at one end these lines intersect, at the other they are about one thirty-second of an inch apart. If a globule of less than this diameter be moved between the lines towards the point of their intersection, it will at length arrive at a spot where its exterior points, when observed through a glass, are exactly over the two converging lines. The weight corresponding to a globule of this size is marked on the edges of a scale, and can be read off directly. By this ingenious contrivance a practised eye, aided by a glass, may determine weights smaller than 1 milligramme, to an accuracy reaching 1-70th of a milligramme, or even less. A chapter on the assaying of lead ores, and other plumbiferous compounds, concludes the first division of the book, the student having been by this time well supplied with all that is necessary to enable him to study the metallurgical portion of the work with the greatest possible profit.

In the metallurgical part, Dr. Lamborn gives a general view of the systems in use for producing the marketable metals, silver and lead, from their ores, as delivered from the miner or dresser to the hands of the smelter. The various descriptions of reverberatory furnaces, cupola furnaces, and hearths, are in turn described; and the treatment of oxidised products, the separation of silver from rich lead, and the treatment of silver ores by the wet way are minutely explained. The hunter and settler in Missouri, in the United States, early learned to prepare the lead necessary for making their shot and bullets by building a fire in the hollow of a fallen tree or in an old stump, and smelting the pieces of galena that they picked up on the surface. The desired metal collected in the ashes, and was remelted in a pot or a spoon, or re-smelting to be ready for casting. Afterwards an equally simple stone hearth was used; it consisted of four walls, with a bottom inclined towards the side which contained the tap-hole, from which the metal flowed. The construction of this hearth was no more primitive than the plan by which it was operated. A layer of heavy logs was laid down in the bottom, then followed a stratum of split wood, upon which the galena was thrown, and the whole covered with a layer of small wood. The fire was kindled in the front arch (around the tap-hole), and the process of reduction commenced. The reduced lead flowed down through the front aperture into the basin. The combustion lasted about 24 hours, and about 50 per cent. of the weight of the ore was obtained in metal. The large proportion that remained among the ashes was partly collected by a subsequent treatment in what was called the ash-furnace. This primitive plan of smelting lead is now obsolete, and its place is supplied by the more economical blast and reverberatory furnaces. The German and English methods of cupelling are next described, and the various processes of amalgamation; attention being then turned to the treatment of silver ores and argentiferous products by the wet way—Ziervogel's, Augustin's, and Von Patera's methods being each accurately described. The work is in every way equal to its predecessor, and will form a valuable addition to the metallurgist's library.

* A Rudimentary Treatise on the Metallurgy of Silver and Lead. By Dr. ROBERT H. LAMBORN. London: John Weale, High Holborn.

## THE ORIGIN OF MINERAL VEINS.

In the Journal of May 11 we briefly alluded to the publication of a work upon this subject by Mr. Thomas Belt, of Newcastle-upon-Tyne, and now purpose more fully detailing the views entertained by the author. There are some features in the gold-bearing quartz veins of Australia (upon a study of which Mr. Belt founds his theory) that entitle them to the particular attention of the geologist. In the auriferous districts of Australia the veinstone is pure quartz—the metal native gold, and there is every probability that we have both presented to us in the form in which they were originally deposited. It is evident that veins so filled will afford a much more secure and simple basis for an investigation into the origin of mineral veins than those lodes in which a secondary arrangement must have taken place. In May, 1851, the discovery by Mr. Hargreaves of gold in New South Wales had become generally known, and great excitement prevailed in consequence of a report that a solid piece of gold weighing 13 ozs. had been found in an auriferous drift at Summerhill Creek. A general prospecting of the country followed, and other gold fields were opened. Mercantile and agricultural pursuits were almost deserted, numbers throwing up their employment and joining in the search for the glittering metal. The gold discoveries in New South Wales were speedily followed, and completely eclipsed, by those in the sister colony of Victoria, where for a time the amazing riches of Ballarat, Bendigo, and Mount Alexander overturned and convulsed the usual order of society, and attracted to the shores of Australia many thousands of eager and adventurous emigrants from Europe. The search was at first confined to the beds and banks of creeks conveying the watershed of ranges of highly inclined and crystalline schists, traversed by numerous veins of quartz. When the auriferous drift was traced to its source it was invariably found to commence in the neighbourhood of the quartz veins cutting through the older rocks, and specimens of gold still adhering to pieces of quartz also pointed to the latter as the original matrix. Although, therefore, it was well understood that the gold in the alluvial deposits had been derived from the disintegration of the quartz lodes, it was long before they came to be systematically worked. Gradually the richness of some of the quartz veins was forced upon the attention of the miners, who ultimately went to the other extreme, and commenced operations on almost every quartz vein, even where no gold could be perceived in the quartz. Most of these adventures failed, but although it was proved that every quartz vein did not contain gold, many were found that yielded more than the most sanguine could have expected. The amount of gold obtained from the lodes promises soon to equal the supply from the alluvial deposits, an immense capital being employed in the prosecution of quartz mining.

The arrangement of rocks in Victoria is the same as Mr. Belt has found to prevail in every gold field that he has visited. The strata through which the granite has burst are analogues of the lower Silurian rocks of Europe. Near to the granitic centres the strata are most highly indurated, and traversed by joints and planes of cleavage. Their strike is nearly true meridional. A most noteworthy feature in the quartz veins of Victoria is the fissuring of the quartz. The irregular fissures cannot be confounded with the slaty cleavage or the jointing of altered sedimentary strata, for the quartz is divided into irregular multiform pieces. Nor is this structure connected with any fracture or dislocation of surrounding strata; it prevails in every quartz vein, and through all parts of the veins. There has evidently been a shrinkage of the whole mass after its consolidation. He has seen a somewhat similar structure to prevail in trap dykes in England. The fissured nature of the quartz allows water to percolate freely through it, yet little change in them is to be traced to its action. He well knows the difficulty of reviving the igneous theory of the origin of mineral veins, especially now, when even the igneous origin of granite is questioned by able mineralogists and chemists; but its solution of the phenomena has appeared to him so conclusive that he fully believes its adoption depends only upon the perspicuity with which he can lay his evidence and arguments before the scientific world.

In the succeeding chapter Mr. Belt shows, satisfactorily we think, that the connection between intrusive rocks and mineral veins is intelligible, if we admit the igneous origin of the former. We then perceive that quartz veins are as naturally produced by granitic eruptions as the acorn by the oak, or the swing of the pendulum by the laws of gravitation and inertia. The philosophers who contend against the agency of heat in the production of crystalline rocks must, he says, be reminded that even their watery solutions owe their fluidity to the agent they contemn, for strictly speaking water is but fused ice. The plutonist has as good reason to call his theory a chemical one as he has who contends that crystallisation must have taken place in the wet way, for no one will deny that chemical changes are continually brought into action and intensified by the agency of heat. The most that the advocates of watery solutions can prove, and what their opponents may readily admit, is that during the liquefaction and crystillisation of the plutonic rocks water was present, and that since their consolidation changes may have taken place through the percolation of the same element.

The whole of the arguments advanced are evidently those of a man who is not only thoroughly acquainted with the subject upon which he writes, but who is also particularly careful to write nothing offensive to his opponents, or calculated to injure either their feelings or their reputation, so that, although his arguments will, doubtless, elicit many valuable truths, we may reasonably hope that all discussion upon his opinions may be free from personalities, and equally clear and concise. Mr. Belt reminds us that we seldom find the metals pure: they mostly occur as alloys. Thus, the native gold of Australia always contains an appreciable quantity of silver and other metals. An analysis gave—Gold, 99·283; silver, ·437; iron, ·203; copper, ·069; bismuth, ·008; and it is a remarkable fact, and one unaccounted for by the opponents to the igneous theory, that only heat is known to produce the alloys. Examples of the occurrence of the ores of metals in igneous rocks, which might be considerably multiplied, are sufficient to prove the possibility (we should be more inclined to say the probability) of their igneous production, and they form the most conclusive answer that can be given to the assertion of Mr. Evan Hopkins that such production is "inconsistent with analogy, and contrary to facts." The conclusions Mr. Belt arrives at are briefly summed up thus:—"1. That the auriferous quartz veins of Australia are filled with minerals which are not liable to be decomposed by the action of water, and which apparently now exist in the same state as they were originally deposited.—2. That in these veins the distribution of the gold, and the structure and arrangement of the quartz, are explained by the theory that they are fissures that have been filled with molten silica, containing entangled metallic vapours.—3. That mineral veins are constantly found in connection with igneous rocks, and that in some cases, as in Cornwall and Wicklow, a regular sequence of events have followed the intrusion of molten granite, by which granitic, porphyritic, and mineral veins have been successively formed.—4. That the fusion of rocks in the bowels of the earth, and their subsequent consolidation, supply the requisite conditions for the rending open of the superincumbent rocks, and the filling of the rents so formed with fluid matter, varying in composition according to the comparative depth from which it has been projected.—5. That the objections raised against the igneous theory of quartz veins and of granite are not tenable, being based either on a misapprehension of the theory, on a misinterpretation of observed facts, on experiments where the natural conditions were not fulfilled, or on the obscurity in which certain delicate chemical questions are still involved.—6. That the investigation of the origin of the lodes of the baser metals in Europe has been impeded by the confusion arising from the mixing up of the results due to secondary agencies with those referrable to original deposition.—7. That mineral veins and trappean dykes have many features in common, and that the points in which they vary may be explained by a reference to the different conditions under which the igneous matter has been developed."

## THE PAST AND PRESENT LIFE OF THE GLOBE.

How frequently is the study of an interesting and useful science neglected owing to the inability of the teacher to elucidate the facts connected with it except in a purely machine-like manner, which leads the student to conclude that no subject can be more tedious and repulsive; and how gratifying is it to meet with a lecturer or author who is sufficiently master of his profession to enunciate his facts in such a style that they are at once impressed upon the memory of the student, and that the science is invested with an interest which renders further investigations concerning it a pleasure. A very attractive little volume on Palæontology,* by the author of a valuable series of text books on Geology, has been published, and from the vast amount of information which can be obtained from it we do not hesitate to predict that it will enjoy a large share of patronage. The object of the author has been to give a popular sketch of the World's Life-System from the earliest organisms in the stratified crust to the forms that now adorn and people its surface; to excite rather than satisfy the curiosity of his readers, by impressing them with the universality and uniformity of natural law, believing that there can be no true notion of Nature or of Nature's requirements, while her facts are viewed through the medium of the miraculous. In fact, the book is one of those which, by teaching how to learn, and what to learn, is infinitely more useful than by far the larger proportion of the so-called purely scientific works, the aim of which appears to be to prove that the authors have studied their subject *ad nauseam*, and until they have fallen into such inextricable confusion that they conclude nothing short of an entirely new theory can possibly render the science intelligible.

Fragments of rock which the road-maker would consider sorry material for his purpose, and which the feet of the ignorant might spurn from their path, are in the eye of science invested with as high an interest as the obelisks of Egypt or the sculptures of Nineveh. The antiquarian pores with enthusiasm over the lines and letters of the one, and endeavours to decipher the unconnected history of a few thousand years; the geologist bends with equal delight over the forms and impressions on the other, and tries to gather therefrom some intelligible glimpses of a past, compared with whose duration the chronology of man is but as the moments of yesterday. Worthless as the chips may seem, the eye of the zoologist detects in this the pore-work of a coral, in that the valves of a shell-fish; on this the scales of a fish, on that the plates of a reptile; in this the bone of a bird, in that the bone of a mammal; in this the grinder that milled the leafy twigs of the forest, in that the trenchant tooth that preyed upon the flesh of other creatures. Every trace becomes a letter, every fragment a word, and every perfect fossil a chapter in the world's history, which tells us of waters that were thronged, and of lands that were tenanted by life; of races that lived, and multiplied, and perished; of others that took their places; and this so often repeated that the mind at first excited by the marvels it unfolds begins at last to grow weary of the review, and the finite creature loses itself in the contemplation of the Creator. It is true that many of the fossils are so fragmentary and obsure that they cannot yet be deciphered; and others are so different from anything now existing in the vegetable or animal world that no definite place can be assigned them. It is also true that the science of palæontology has little more than passed its infancy, and that of the innumerable relics entombed in the rocky strata of different regions only a small proportion can have yet been discovered. Notwithstanding all this, so enthusiastic has been the research, and so attractive the study, that much satisfactory work has been done; and by the aid of some of the highest minds in Britain, France, Germany, Italy, and America, palæontology has already taken a permanent place on the roll of human knowledge. Under the hand of a Brougniart, a Goëppert, or a Lindley, these stony stems have started anew into life and verdure, and tangled the swampy jungle, or waved in the upland forest; under the reconstructing skill of a Cuvier an Agassiz, or an Owen, these scattered bones have been reunited in intelligible symmetry, and once more repeopled the earth, the air, and the ocean; while under the magic lenses of an Ehrenberg these muds, and marls, and chalks have become instinct with life, and ancient waters swarm with innumerable forms.

Fifty years ago the miner and engineer had little to direct them in their researches save the very variable tints of colour, the structure, and other external aspects of rock masses. Now, however, a fossil branch, a tooth, or a few scattered fish-scales, will enable them to identify with certainty the strata in distant localities, and so save years of unnecessary toil and thousands of useless expenditure. There is, for instance, in Britain a red sandstone *beneath* and a red sandstone *above* our most valuable coal fields—so like in many respects, that which is which mere mineral characteristics cannot always determine. Shall we ignorantly dig through the one for that mineral fuel which never lies beneath it, or shall we, mistaking the other, maintain that it is folly to pierce through it? Where the mere mineralogist stands perplexed the palæontologists proceeds in the confidence of certainty from the detection of of a *Holoptychian* fish-scale, which stamps the existence of the old red, or the discovery of a tiny *Palæoniscus*, which is equally decisive of the new. Exalted as may be the task of solving the physical and vital problems of the globe, the duty of turning to account its mineral and metallic treasures is not less worthy or important. Science acquires fresh power and position when combined with practice and philosophy, new dignity when ministering to humanity.

We would willingly give a complete epitome of the contents of Mr. Page's book, could we hope to do so satisfactorily within the limits of a newspaper article; but the treatise is so replete with interest, so concise, yet lucid and readable, that we can do no more than commend it to the attentive perusal of our readers. In the lectures of Prof. Morris, of University College, London, to which we have on several occasions referred, we have had evidence that in the hands of a competent instructor the science of geology, so oft declared to be a repulsive study, can be rendered lovable, and in Prof. Page's sketch of the World's Life-System we have an equally convincing proof that a book can be written upon the science of palæontology, which can be read by any one, and which no one can look into without deriving both pleasure and profit from the study.

* The Past and Present Life of the Globe: being a Sketch in Outline of the World's Life-System. By DAVID PAGE, F.G.S. London and Edinburgh: Blackwood and Sons.

## GEOLOGICAL MAP OF THE FRONGOCH DISTRICT, CARDIGANSHIRE.

We have before us a map of the principal lead-bearing district of Cardiganshire, enlarged from the Ordnance Geological Map, commencing northwards from the great silver-lead mine of Goginan, and extending southwards through Frongoch and Grogwinion. This map shows the ranges of productive rock running across the east and west lodes, indicates the result in the formation of the great mines for which that country is so much celebrated. We undertake to say that this map will be found of much importance in enabling people to judge for themselves as to the presumed value of any mineral grant or mine in this district. For example, let us take the great north and south channel of Frongoch. We find upon it the very rich silver-lead mine of Goginan, and the rich lead mines of Frongoch and Grogwinion, yielding immense produce and great profits; while the infant mines of Jyllwyd, Aberyffwyd, and Blaen Caenant, are well placed in it, and begin to yield good produce. Further southward, in the same channel, are the nacent mines of Mynyddbach and West Lisburne, not yet explored, but situate in such localities that it is easy to foresee the great probability of their becoming good mines. It is unnecessary to dwell upon the value of such information as this to a discerning public, who, instead of having to consult a host of engineers, may refer to their own libraries, and get for the merest trifle the desired information, and that information derived from a source that cannot be prejudiced—that is to say, the study and exposition of the laws of Nature. In the next north and south range of rock, travelling eastward from the Frongoch channel, are found the Logylas, Penygist, Glogfach, and Cwmbrwyno Mines, and the rising mine of South Lisburne, recently opening with great masses of ore discovered, in the joint lands of the Earl of Lisburne and Mr. William Chambers, of Hafod, to the latter of whom the mining public interested in Cardiganshire is principally indebted for the enlightened policy of a reduction of the royalties, assimilating this part of Cardiganshire to the most favoured districts of Cornwall, and even surpassing many of the Cornish landlords in encouragement to new mining in a rich and *bona fide* mining country. Further eastward runs the north and south channel of the great Esgair Mwyn Mine, in which, in the centre of the Hafod estate, the well-loaded Logylas and Cwmystwith lead vein crops up, filled with metal to the surface; and in the same channel and the great Frongoch lode is now commencing the mine of North Hafod, which, from its situation, the orey character of its vein, and the antecedents of the rich Frongoch Mine, may soon turn to a very valuable account.

There are a great many other remarkable points in this map, such as the channel of

the great Cwmystwith Mine, but the map had better be consulted, in order to trace and discover rich mines. It is to be had of Mr. Spargo, Gresham House, at 2s. 6d. each.

## ANCIENT GEOLOGY—No. V.

In our last chapter we spoke of the mutability of the rocks, and the incessant changes going forward in the configuration of the surface of the earth. We shall now take notice of the motive powers that we conceive are engaged in these operations, and in our next chapter we propose to deal with the colours found in the crust of this planet, as we are convinced that the laws which gave them origin are also intimately connected with the formation of metal. The visible and active powers most tangible to the human faculties in the mutability of the earth's crust are those demonstrated in the phenomena of earthquakes and volcanoes. These remarkable classes of power are incessantly at work, and while the rock is trembling and breaking under their influence, in the East, in China, and Japan, the same causes are crumbling down cities, riving the solid structure of the rock, letting down reservoirs of water, and inhuming hecatombs of the human family in the western world. The range of travel of these forces demonstrates their uncontrolable power, and affords us in some degree a comparative standard by which to measure or guess at their potency. Volcanoes, again, by their mode of action, give us some enlightenment as to the nature of the power in action, and the process by which it is governed, and the continued alteration in the nature and character of metalliferous veins speak as to other more silent causes that are continually at work in the great laboratory of the crust of the earth, producing and modifying those metals so intimately connected with the comforts of man. But we will first consider the earthquake and its causes. It is almost impossible to describe the nature of the shocks of an earthquake to those who have not experienced them; the terrible noise with which they travel, the terrible sensation imparted by the undulating wave of rock. It is heard approaching for miles ere it arrives, like the sound of a multitude of wagons on a well-macadamised road, and with other unearthly groanings in the rending of the solid rocks far below. If in a wooded land, the giants of the forest fall prostrate on every side, houses are shaken off their foundations, and in the western world, long subject to the old Spanish dominion as well as to those of earthquakes, the supplication to the Virgin, "Ave Maria purissima madre de Dios ruega para nosotros pecadores," goes up from every mouth. I have experienced many an earthquake, and I can only attribute the effects manifest at the surface to the rush of a volume of gas, travelling from one point to another, probably hundreds of miles distant, through the masses of rock below, riving them as a wedge rives timber in the direction in which it is driven. But, the questions will be asked, where does it come from, and how is it driven? My experience gives me to believe that in the granite shell of this planet there are immense caverns, which get filled will gas, and which, when too full, are subject to spontaneous combustion; that the explosion when unable to break through its rocky canopy forces a way through the rock to some channel of escape. Sometimes it arrives at a barrier, where, penned up, it labours until it has forced a passage by forming a mountain at the surface, as it did at Jorillo, in Mexico, in 1792; at other times it reaches established volcanoes, and lights up the craters after a period of extinction, and there is no reason why this should not occur periodically, as at Vesuvius and Etna, as when the charge of gas has blown off it would require time to replenish from the natural resources of this gas-giving earth. That the earth is continually giving forth gas from the interior to the surface, passing, so to speak, in showers upwards wherever it can penetrate, there can, I think, be scarcely a doubt; the whole subterranean cosmos seems to prove this; the earth seems to breathe gas through every pore, and the slates show a thousand divisions of fissures, which appears to me to evidence the action of the passage of gas. It is seen in a thousand shapes at the surface, it is heard in a thousand sounds underground, but its action seems more developed in the mountainous regions of metallic veins and coals than in the flatter countries and unmetallic strata. The laminated and striated films of metal that go to form the mass, with all its beautiful and frondose radiations—the needle-like crystals shooting from the sides of old subterranean workings on metallic veins, all show the emanations of gas from the interior, and where the metallic gases are acted upon by the electric current, it may account for much of the beauty, colour, and pagentry of the metallic kingdom; but we shall devote a chapter to this subject in future, and then go on to consider the nature and character of the old slate formation.

## THE MINERAL OILS OF AMERICA.

The petroleum oil springs of America are exciting so much interest at the present time, that importance naturally attaches to all reliable accounts concerning them; and as the whole subject has been very carefully surveyed in a recent number of the *American Gas-light Journal*, we may avail ourselves of the information contained. The numerous reports from the petroleum regions of Pennsylvania and Ohio, a few years ago, respecting the immense oil discoveries, received at that time but little more attention from the business and manufacturing world than to elicit a passing remark, or to be merely the subject of mention as an interesting circumstance. The information regarding the yield of the wells, and the vast number of springs discovered, was of so marvellous a character, and the reputed amount of oil pumped from single wells was so incredibly large, that doubts were cast upon the whole enterprise, and those who left the large cities to engage in the prospecting for oil in those regions were regarded as rather visionary in their ideas, and were deemed to be pursuing a phantom which would soon lead them into an unenviable plight. Time, however, has demonstrated the value of the production of the petroleum regions; and instead of the supply failing, as was at first predicted, the reports of still larger yields, and of still newer resources, are being circulated, and the fruits of the enterprise amply verify the statements regarding the increased supply of oil. The local papers of Western Pennsylvania, Ohio, Kentucky, and other states, are laden with items announcing new and valuable discoveries, and these new openings seem to inspire explorers with still greater zeal, and many new sources will doubtless be inaugurated. It is not strange that amid all the authenticated accounts of valuable openings numerous exaggerated and untrue statements should likewise appear, and frauds be perpetrated by unscrupulous land owners, desirous of realising by swindling inexperienced operators. Of course, many of the reports of enormous yields are bare falsehoods, issued by designing speculators to deceive the unwary: but, notwithstanding this, we may regard the petroleum basins as sources of great wealth, and which promise to be productive of large revenue.

Thus far the demand for the oil has been far in excess of the supply, and the rapidity with which it is forwarded is indicative of the energy of those engaged in raising it. A very large proportion of it is shipped to France and Germany, where it is largely employed in the manufacture of aniline, fuschine, and other brillant colours for dyeing. It is principally used in America as an illuminating agent and as a lubricator; for both of which purposes it is, after a slight rectification, admirably adapted. Already the greatly increased supply of this fluid is having a damaging effect upon other articles which have been relied on as artificial illuminating agents, and it is proper to suppose that it will eventually become the main reliance of all who desire a cheap, pleasant, and safe light, where gas is not used. The popularity of petroleum and coal oils as illuminators has seriously interfered with the whaling trade, and the statistics of that traffic show a remarkable falling off in the supply of whale oil, and a diminution in the number of the vessels employed. In the year 1844, the total number of vessels engaged in whaling in the United States was 635, the aggregate tonnage being 200,485. In 1857 the number of vessels was 655, aggregate tonnage 204,209. In 1861 the number of vessels has decreased to 514, aggregate tonnage 158,746. In 1858, 200 ships went into the North Pacific for whale oil, whereas in 1861 less than 100 are expected to go. These figures exhibit a large decrease within the past four years, and this will probably continue. The diminution in the number of vessels is attributable in some measure to difficulties experienced by the whalers, owing to a decrease in "catch." The whales, it is said, have grown wild, and are constantly changing their position. This, together with severe weather experienced in their usual latitudes, have contributed to the disastrous result. But the most important cause of the falling off is undoubtedly the largely increased consumption of petroleum and coal oils, and the inauguration of gas-works in towns where whale oil was previously used as an illuminating agent. If the statistics of the petroleum business could be accurately compiled, they would present a long array of figures, representing the amount raised and forwarded to market, and would afford an evidence of its importance as an article of trade. Already it has diffused a spirit of life and energy into a before comparatively quiet region; it has swelled the population of villages and projected new towns. The industrial arts have been largely stimulated, and the increased demand for steam-engines, pumps, barrels, and other implements required for raising the crude oil from the wells and preparing it for market has opened new fields for inventive genius, the consequence of which has been that many improved methods have been adopted for producing the oils, effecting an economy both in time and labour. A truly reliable account of the geology of the petroleum regions is much needed. The *rationale* of the formation of the oil is not yet accurately defined to the unanimous satisfaction of scientific men; different theories being held in regard to this subject, as is the case with many others. The most natural supposition would be that it is a distillation of coals conducted in Nature's laboratory, under modified conditions of heat and pressure. This is doubtless correct to some extent, as certain petroleums display such characteristics as to prove their production from bituminised plants; while at the same time other samples indicate their probable origin from animal tissue by certain unmistakeable evidence. Many of the more recent discoveries of oil wells have occurred in places hundreds of miles from any known coal fields, and where it is not possible for coal to exist, owing to the peculiar geological character of the country. Thus oil has been discovered in many parts of Canada, far from the coal formations, and veins have been struck there which yield a most abundant supply.

With respect to the history of Coal Oils, it is likewise remarked that the production of oil from coal and petroleum, or rock oil, having passed through its experimental stages and become an article of commerce, and having assumed a form of utility which commends its use in all localities where gas is not attainable, as well from its illuminating properties as its economy, it bids fair to compete successfully with the production of burning fluid and camphine, and finally to, perhaps, exterminate their manufacture. The first attempt to introduce coal oil practically to the people of the United States was made by the Kerosene Oil Company, in 1857, and their efforts in this direction were quickly seconded by those of the Carbon Oil Company in December of the same year, by the first introduction of oil made from petroleum, for burning in the coal oil lamps. The beginning thus made has been steadily followed up through some trying fluctuations and depressions, growing partly out of the inferior quality produced, and partly from the fact that the demand speedily outran the supply, and the public discontinued its use in the fall and winter of 1859, from its scarcity, poor quality, and high price. American coals are not well adapted to the production of coal oil, as the yield of oil is not sufficient to make manufacturing from them profitable, as compared with the greater yield and superior quality of foreign coal—especially that obtained from Scotland and New Brunswick. But this defect Nature has abundantly made up in the great deposit of natural oil. The yield of crude oil per ton—of native and foreign coal—is given below, and, in addition to the greater quantity obtained, the imported coal has the advantage of producing an oil much lighter in specific gravity, hence much superior for illuminating purposes:—

| | | |
|---|---|---|
| England—Derbyshire | 82 | gallons per ton. |
| Scotland—Boghead | 120 | " " |
| " Lesmahagow | 96 | " " |
| New Brunswick—Albert Coal | 110 | " " |
| American—Pittsburg | 49 | " " |
| " Kanawha | 71 | " " |
| " Falling Rock | 80 | " " |
| " Cashoton | 74 | " " |
| " Breckenridge | 100 | " " |
| " Petroleum Springs | — | " " |

Alabama, Tennessee, Pennsylvania, Virginia, Ohio, Kentucky, Texas, Canada, and California produce from 60 to 95 per cent. of the illuminating oil. The Breckenridge shows the most favourable among American coals; yet the most satisfactory results are obtained from the Scotch Boghead coal. These coals also yield oils of heavy gravity, and by some it is claimed that they possess superior lubricating properties; but this is a point not yet satisfactorily established. Doubtless they are useful to some extent as lubricators, mixed with animal oils, but for such purposes their value is but small. The heavy oils also contain a large percentage of paraffine, which is used extensively and successfully in the manufacture of so-called paraffine candles, of fair quality, very little inferior to sperm. The discovery of the great oil deposit of Pennsylvania has given a great impetus to the production of these oils, and the certainty that these deposits are of vast extent causes the prospective business in this class of oils to loom up very largely. The first petroleum oil, known as "carbon oil," was introduced into New York in 1857, and was obtained from a salt well at Tarentum, on the Aleghany River, Pa., and was introduced to the public by a gentleman now connected with the Carbon Oil Company.

The great demand which immediately followed its introduction, and the remunerative prices obtained, stimulated further search for these oils, and led to the development of the great oil deposit, of which almost fabulous accounts have from time to time appeared in the newspapers of the day. The deposit is of great extent, and reaches in a direction nearly north and south from Lake Erie, through the states of New York, Pennsylvania, Ohio, Virginia, Kentucky, Tennessee, Alabama, and Florida, and also exists in abundance in Canada West. Its principal development in Canada is at a place called Enniskellen, about 20 miles from Port Sabina. But, although existing in very great abundance in Canada, its commercial value from that section is small, owing to the unconquerable and offensive odour with which it is impregnated. We give below the number of square miles of the great oil deposit, as far as yet determined, although it doubtless extends over a much greater area:—

| | Sq. miles. |
|---|---|
| Alabama | 1300 |
| Tenessee | 1000 |
| Kentucky | 2000 |
| Virginia | 1800 |
| Ohio | 1500 |
| Pennsylvania | 2500 |
| Florida | 500=10,600 |

This petroleum also exists abundantly in Texas, although entirely undeveloped in that state; and on the Pacific coast, in California, there are immense deposits of oil and bitumen, which have as yet attracted but little attention. A belt of this oil deposit, of great extent, also exists west of the Mississippi, but how extensive is yet undefined. It is also found in Illinois, and doubtless will yet be discovered in many other localities in the United States. We are thus particular in giving some idea of the extent of the deposits of this material, as we think it is ere long destined to form a very important article of commerce, both for domestic use and for export.

This rock oil is peculiar in its chemical combinations and bases, and will doubtless yet be applied to a great variety of important uses; but our purpose is to give an idea of its present or immediate importance as an article of trade and manufacture. As to the origin of this oil opinions differ; the popular idea is that it oozes from coal, or has been expelled from it by heat or pressure; but many facts bear against this theory, and the probable truth is that it is an independent or original deposit, having no connection with coal, but closely allied to it—although sometimes found in geological formations which absolutely forbid the existence of coal, as in Canada West. But our purpose is not to discuss this, but to give its present dimensions and probable expansions, with the prices it is likely to command in the future. The production of petroleum, which occurs at the present time mainly along Oil Creek and its tributaries in Pennsylvania, in the vicinity of Mecca, Ohio, and Parkersburg, Virginia, may be stated as follows:—

| | | |
|---|---|---|
| January, 1860 | 30 | barrels per day. |
| July | 500 | " " |
| December | 1600 | " " |

This oil has commanded an average price in its crude state at the wells of 18 cents per gallon. At the present time it is selling for about 23 cents, although it has been sold during the past summer as low as 10 cents per gallon. But as we estimate the yield for July, 1861, at 5000 barrels, of 40 gallons each, per day, it is probable that the price will decline to a lower point than it has yet reached. The manufacture and sale of oil, refined from coal and petroleum, which has already had a marked effect on the whaling interest and the production of fluid, may be stated as follows:—In 1858, 100 barrels per day, at an average price of 80 cents per gallon; in 1859, 300 barrels per day, at an average price of 100 cents per gallon; in 1860, 1500 barrels per day, at an average price of 70 cents per gallon. Its production before the close of 1861 will, doubtless, reach 5000 barrels, or 200,000 gallons per day, or upwards, at an average price below rather than above 50 cents per gallon. As it is an oil perfectly free from danger of explosion, gives a light fully equal to gas, and is more than three times as lasting as fluid, it is very probable that when these low prices are reached, whales may have some rest, and the camphine operators turn their attention to the manufacture of rock oil. Much capital has been invested in the manufacture of coal oil, but as the rock oil can be pumped so much more cheaply than the oil can be extracted from coal by the agency of heat, coal oil manufacturers will have eventually to give over the field to the rock oil. We give a brief description of the oil wells: These are borings through the solid rock from 3 to 6 inches in diameter, and of various depths, from 50 to 500 feet, the drill being kept in operation till a vein of oil is "struck," or the attempt abandoned. If successful, the hole is tubed, and a pump, worked by hand or the feet, or steam, put in operation, and rude tanks erected to contain and separate the oil and water which flow from the pump. The wells in successful operation number about 200, principally in Pennsylvania, Virginia, and Ohio, and the total number in operation and in course of construction at the present time is about 2500. The average cost of boring and fitting up is about $1200, and the average production of oil from the successful wells is about 8 barrels, or 320 gallons, per day each.

It appears that within the past year over half a million of dollars have been expended at Pittsburg for steam-engines, boilers, tubing, &c., for the oil district: 17,000 barrels of crude oil have been received, and $219,500 worth of purified oil disposed of; $176,976 were received for steam-engines and boilers, and $178,002 for tubing and drills. The cost of an engine has averaged less than $300, but never above that sum. The amount of oil sold during the year 8700 barrels. Amount realised, at $25 per barrel, $219,506. Total cost of steam-engines, boilers, machinery, tools, ropes, &c., purchased here for oil operations during the last 12 months, $527,720. Value of refined oil sold by our refiners, $219,500. Value of oil received by railway and river, $203,208. This is exclusive of the business done in Pittsburg in coal oil.

MINERAL COAL.—It may justly be said that few more interesting papers have been contributed to the Historical and Geological Society of Wyoming (Pennsylvania) than the lectures of Mr. Volney Maxwell, of Wilkes Barre; and although those lectures are too elaborate to be inserted verbatim, we may avail ourselves of the opportunity to extract a few of the more interesting details. In a highly popular manner Mr. Maxwell describes the marvellous reactions and affinities of oxygen for the other substances found in nature, and explains the very beautiful experiments which prove the diamond to be carbon, and the only pure carbon to be found, seen, and handled, and that the diamond is closely related with charcoal, with anthracite, and with bituminous coal. After explaining the various process of Nature, he alludes to the fact that the animal kingdom as it now exists furnishes to the atmosphere nearly all its supply of carbon, in the form of carbonic gas breathed from its innumerable lungs; while on the other hand, the vegetable kingdom yields to the atmosphere in return its proportion of oxygen for the sustenance of animal life. With these facts we must connect another, bearing strongly upon this point; and it is the division of the animal kingdom into two great classes—first, those animals living upon vegetables; and secondly, those living upon flesh; for it is clear that before the vegetable kingdom was brought into existence by the fiat of the Almighty no vegetable-eating animal could have existed; and, consequently, that the second class of animals, living upon flesh, could not have existed until vegetation had reared up a generation of the first for the latter to feed upon. This (he continues) seems clear; and I had written just this far, when it first occurred to me to test this theory by the order of creation, as stated in the first chapter of Genesis. My recollection of that order was entirely at fault, and I turned to it with some misgivings, but they were all useless. In the 11th and 12th verses the creation of the vegetable kingdom is mentioned; in the 20th verse the creation of the fishes is stated; and in the 24th the creation of the animal kingdom is described, commencing with the cattle, as the vegetable kingdom commenced with the grass of the field. Surely, no one need ever fear that the truths of the Bible, rightly understood, will ever conflict with the truths recorded or developed by Nature, for both have for their author the same Great Being, who "cannot lie," and if poor Galileo, and the ignorant Romish priests who persecuted him for his theory of the earth, had read their Bibles as they ought, they would there have found the truth revealed that the earth is round; they would have seen that inspiration speaks of it as the *earth ball*; and also that "He stretcheth out the north over the empty place, and hangeth the earth upon nothing;" thus revealing deep physical truths, which astronomers laboured for centuries to discover, because they overlooked them in the revelations of their Creator. In his second lecture Mr. Maxwell alludes to the first application of the Wyoming Valley coal in a very pleasing manner. So early as 1776, and afterwards during the war, two Durham boat loads of coal were annually taken from a mine above Mill Creek, and used in the armoury at Carlisle (the coal of the valley having been used eight or nine years previously by Obadiah Gore and his brother, who worked as blacksmiths). From the Revolutionary War, long years elapsed before it was used in grates or stoves. All attempts thus far to use it as a household fuel had failed; but as it burned well upon the blacksmith's hearth there was a strong feeling among people of intelligence that it ought to be burned upon the domestic hearth. Various were the suggestions made; but as a strong blast of air was supposed to be necessary to its combustion, the thoughts of men were turned to the adoption of some expedient for its supply. Some thought of burning it in grates such as we now use, by means of an air tube passing from under the grate through the hearth, so as to let a supply of air come up from below. Others, who thought such a supply would not be sufficient, supposed it might be increased by clock-work machinery, driven perhaps by a weight or a spring. But the rotary fan was not then in use, and as only the common bellows were thought of, others supposed that the necessary machinery, however simple and cheap, would cost more than the fuel would be worth, and none were willing to try the experiment. Such (continues Mr. Maxwell) were the speculations listened to by the children of that day; and well remembered by the most aged fathers and mothers of this. But these speculations were yet to bear fruit. The late Judge Fell, well remembered in this community, was a member of the Society of Friends, and had emigrated from Bucks county to this valley. For many years, and up to his decease in 1830, he was an Associate Judge of our Courts, and a gentlemen of intelligence and probity, highly useful to the community in which he lived; and though of modest, unassuming manners, he possessed a sound judgment, and an enterprising mind and spirit. He believed that our coal could be burned in grates. He judged correctly that the natural draft occasioned by a fire would be sufficient, if the coal in sufficient quantity were only placed in a proper position. It is rational to believe that these were his views; for his first experiment, known to his descendants now in this town, was made with a wooden grate, very much of the form of those now in use. It is amusing now, to think of burning coal in a *wooden* grate, but his logic and economy were based upon sound principles. He reflected, no doubt, that it he could make his coal burn so freely as to destroy his wooden grate, he could then well afford to make one of iron; and could do so without fear of loss or disappointment. We know not the result of this first experiment, or anything of the particulars; but the inference is reasonable that he succeeded, for his next experiment was more public. One of his daughters, the lady of Col. Dennis, lately deceased, told me that she well remembered the circumstances attending it. The Judge was a practical man, and something of a mechanic. She recollected his going into the blacksmith shop of his nephew, Edward Fell, and of his working with him most of the day, fashioning his first iron grate. Late in the afternoon he brought it home, and setting it with brick, in the fire-place of his bar room, by evening he had kindled in it with oak wood one of the best of coal fires. The interest it excited, and the many visits of curious neighbours anxious to see a stone-coal fire, were also well remembered by Mrs. Dennis. Circumstances equally interesting are repeatedly alluded to by Mr. Maxwell, and were we to extract much more largely from his book the particulars would doubtless be read with pleasure, but we trust these will suffice not only to give an idea of the character of the lectures, but also to induce equally interesting researches in connection with our English coal fields.

## IRON AND IRON MAKING.

The Scotch ironmasters were a quarter of a century in learning the value of the blackband ore after Mr. David Mushet had pointed out its existence and capabilities. This circumstance was natural enough. Very few in the trade pretended in those days to any knowledge of metallurgy as a science, a[illegible]er, therefore, broke through the traditions of the craft, and lectured [illegible] who believed they best knew how to make iron as to how it ought to be made, was set down, by common consent, as a crazy speculator, little better, indeed, than an alchemist! There is a strong reverence for Nature in us all. We know her processes are complete, and that she never goes wrong. A man who has grown up from childhood amid furnaces and forges is apt to acquire a notion, amounting to a superstition, that the routine of "the works" is as natural, or as consonant with Nature, as the phenomenon of human existence itself. We should all listen with incredulity, if not with contempt, to speculations upon prolonging life to a thousand years, or upon increasing our strength to that of elephants, or upon economising our food to the rations of canary birds. We know intuitively that such things, under whatever "ism" or "ology" we may include them, are impossible. We have that instinctive regard for Nature that we almost refuse to listen to such vagaries. Now, however, we may draw the distinction, this sense of a violation of natural proprieties is akin to the sturdy unbelief of the old-time (shall we say the living?) ironmasters. *Croyéz vous que le bon Dieu permettra tout cela?* was the exclamation of the honest Canadian when he saw, for the first time, a steamer ascending the St. Lawrence—the majestic Iroquois of the red man. In like manner men who have all their lives accustomed themselves to look upon a process of metallurgy as being equally immutable as the seasons, vegetable life, or human growth and decay, can hardly believe that the Great Power will permit any wide departure from the established order of things. Even if we take for granted that necessity is the mother of invention, there can be no invention, and, therefore, no addition to known processes, in the absence of necessity. And there are ironmasters in plenty who fail to recognise in a falling market, and in the aspiring efforts of the French and American iron manufacturers, the necessity for improvement.

There are, too, we are glad to say, intelligent and spirited owners of iron-works who are fully alive to the importance of perfecting our "make" of iron, and who perceive wherein our present processes are defective. In Staffordshire particularly, where ironstone costs from 10s. to 15s. per ton at the furnaces, the development of the Wiltshire and Cleveland ores, which it is understood [illegible]cost but from 1s. to 2s. at the tunnel heads, is awaking general attentio[illegible]. It is not, indeed, to be expected that we can always go on wasting, as [illegible] are now estimated to do, 700,000 tons of metallic iron yearly in the bla[illegible]-furnace cinder of our iron-works. As for coal, Mr. Sanderson, of Shef[illegible]ld, and who certainly ought to know something of such matters, estimates that the absolute loss of useful effect of fuel in the best constructed blast-furnaces is 80 per cent., or four-fifths of the whole. Even in the comparatively crude product, railway bars, it is found that from 28 to 30 cwts. of pig are expended in making 1 ton of rails. It must be evident that a manufacture, conducted with such results, is in a most imperfect condition. When we begin with our blast-furnaces, we find them, for the most part wasting the gaseous products of combustion, nearly heat enough escaping for every ton of iron made, to another ton besides. Mr. S. B. Rogers has written perseveringly upon this waste; but thus far our ironmasters do not appear inclined to take up this escaping wealth for any useful purpose. In France it is usual to employ the waste gases in the heating ovens, and in America all the hot-blast furnaces send the hot gases among the heating pipes. As for heating, too, we are where Mr. Neilson left us in 1833. He begun, in 1829, with heating the blast to 300°, and in four years he had worked the temperature up to 600°, where it has been kept ever since, a heat that will "cut lead" being the standard to this day. With Mr. Siemen's "regenerative" furnace, however, a working temperature of from 1300° to 2000° has been lately attained, and the iron, it appears, comes down all the freer and with less coal than ever. If, as we believe is the case, the hot-blast does not in itself at all affect the quality of the iron, a blast of 2000° will be as harmless as one of 65°, and an experiment at the outset should put this matter completely at rest.

The fact is well known to ironmasters, and is, besides, generally understood by those out of the trade, that it is only the difficulty generally experienced in the working of very large furnaces that prevents the attainment of a large gain by working heavy charges. Adhering, as they have done, to low blast pressure and small hearths, our furnace builders, as soon as they ventured upon 16-ft. boshes, have almost always chilled their furnaces. The great furnace erected some years since at the Dowlais Works, 50 ft. 6 in. high, and 19 ft. 10 in. in the boshes, had a hearth only 5 ft. in diameter, the tunnel head being 12 feet across. This relatively small hearth was, no doubt, as large as was practicable with a blast pressure of from 2½ lbs. to 4 lbs., but the long flat slope of the boshes, some 9 ft. in breadth, all around, formed a shelf upon which the charges were sure to, as they did, accumulate. Now, we do not say that every variety of English or Scotch coal will bear a blast of 8 lbs. or 10 lbs. to the square inch, but we are certain that the Welsh anthracite will, and we recommend the Dowlais people to put on engines suited to the work, and to try 12 lbs. They will find, perhaps much to their surprise, that this pressure is entirely practicable, and when they have once put in a 10-ft. or even a 12-ft. hearth in a furnace 55 ft. or 60 ft. high, and having 20-ft. or even 25-ft. boshes, they will find wherein high-pressure blast is profitable. In such furnaces 400 tons of iron may as well be made weekly as 200. Nothing but a powerful blast, at least twice as strong as the heaviest now worked in our furnaces, will penetrate a 10-ft. or 12-ft. hearth, and, on the other hand, as long as we keep to 5-ft. hearths, 20-feet boshes are totally out of the question. The Americans, since 1840, when one of the Ynyscedwyn furnacemen went out to teach them how to make iron with anthracite coal, have been working, successively, to blast pressures of 3½ lbs., 5 lbs., 6½ lbs., 8½ lbs., and, finally 10 lbs., and enlarging their hearths, at the same time, from 4 ft. to 6 ft., 8 ft., and, at last, 10 ft., the latter diameter having been attained in two furnaces only, 18 feet in the boshes, although some years since furnaces 22 feet in the boshes were built with smaller hearths. The blast now enters through from twelve to twenty tuyeres, arranged at nearly equal distances from each other around the hearth. The compression of the blast may be inferred from the fact that with 40 lbs. of steam cut off at half-stroke a 66-in. steam cylinder (10-feet stroke) is employed for a 93-in. blowing cylinder (also 10-ft. stroke). The exit pipes are so heated by the rapid compression of the air—the pistons working at 400 feet per minute—that the hand can hardly be borne upon them, and in summer the leather packing of the blast piston is often puckered with heat. The inequality of blast pressure is so great on each stroke, rising in less than a second from nothing to 10 lbs., that such blast engines will not work coupled, but singly only. A strong No. 1 iron is made, as much as 350 tons having been run off, in one case, in a single week from one furnace. On this scale of production the American ironmaster has a decided advantage, the saving in coal being considerable, and that in attendance very great. The benefits which have been sought from the use of the elliptical furnace are thus attained with a large hearth and strong blast, with which the largest boshes become both practicable and advantageous.

It is a pity that, when we have the pig-iron, we cannot "convert" it, upon Mr. Bessemer's plan, into an enormous bloom at once. We have not come, however, to a general adoption of the process, and it still seems that it does not suit every kind of iron. That there is a large waste, too, in the combustion of iron appears to be admitted. The next most tantalising in-

vention is the "mechanical puddler," which, if it should succeed, will work a wonderful change in iron making. We must confess our fears, however, that however steam-power may supersede the strength of the puddler, it will never acquire his skill. We wish it were otherwise. The blooms turned out by Tooth's process, and sent into Staffordshire, do not, we hear, properly withstand the hammer, but disclose lumps of cast-iron, which do not appear to have been puddled at all. We fear that there is no help for it, and that the quotations of the metal market will depend for some time longer upon the integrity of the puddler's hook. The iron being puddled, we have no doubt that a considerable saving would be effected by the use of rotary squeezers instead of shingling hammers. The former have the advantage of celerity, saving of iron, and the certain detection of imperfectly-puddled blooms. With sufficient hammer-power iron should be re-heated in large masses, whereby the labour now expended in handling would be greatly economised. Krupp, the great Prussian steel-maker, is now making a helve hammer of almost incredible proportions, the head alone weighing 40 tons, and the anvil block 175 tons! The force with with such a hammer will descend upon a pile must be terrific, but it is less, comparatively, than that of a blacksmith's hammer in striking a horse-nail. Reheating on a large scale, without burning the iron, and corresponding hammering, are means upon which we must rely for the cheap production of large shapes, while as for plates and bars we must have rolls of the largest size, so as to do as much work as possible at a single heat.

With these and other means of improvement, it is to be hoped also that we can effect some corresponding advancement of quality. Whether we shall succeed in desulphurising our coal, and in imparting excellence to our ores by mixing Taranaki sand, manganese, or other substances in the blast-furnace, is to be seen. When, however, we see the iron trade organs complacently recording the results of Government experiments, showing a strength of less than 20 tons per square inch, for 2-in. cable iron, it does appear as if improvement was indispensable. It is a consolation to know that, in the present stagnation in the trade, the best "makes" are in good demand. This fact we hope may stimulate our ironmasters to fresh exertions, leading, as we doubt not they will, to fresh successes.—*Engineer.*



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